**What is Chronic Pain?**

Chronic Pain refers to pain problems that continue for a long period of time, often for many years. Usually there is an injury or illness that was initially the cause of the pain. Sometimes, there was no identifiable initial cause. The common theme is pain persisting over time and causing disruption to the person's sense of well being and often to their ability to function in their day-to-day lives.

There are many forms of chronic pain. Perhaps the most common are chronic low back pain, chronic headaches (such as migraine headache and chronic daily headache), fibromyalgia and myofascial pain disorders and other disorders of muscles and joints. Other common causes of chronic pain are chronic neck pain from whiplash injuries, endometriosis and other chronic pelvic pain problems, and pain associated with gastrointestinal disorders (such as irritable bowel syndrome and Crohn's Disease). Other less common causes of chronic pain include diseases of the nervous system including diabetic neuropathy, post herpetic neuralgia and reflex sympathetic dystrophy.

For more information, GOTO:[**www.painexplained.ca**](http://www.painexplained.ca)

People who have chronic pain, particularly if the pain is relatively intense or severe, often struggle with a whole variety of personal, social, medical and occupational problems. These include suffering caused by the effect that pain has had on their lives and uncertainty for the future. Often depression, anxiety and anger become problems as well. Frequently people with chronic pain are unable to carry on their usual activities, including their occupation, and often become engaged in struggles with their employer, workers compensation or their disability insurer.

For chronic pain support & advocacy information, GOTO: [**www.chronicpaincanada.com**](http://www.chronicpaincanada.com)

Family members frequently try to pick up the roles which chronic pain sufferers are no longer able to fulfill. This may lead to substantial changes in their lives and possibly to resentments and family conflicts. Often people with chronic pain struggle with several or many of these issues. Adapting to a life with chronic pain can be a significant and sometimes overwhelming challenge.

Coping with and adapting to chronic pain is the area where Psychology has the most to offer. A psychologist may be able to help a person suffering with chronic pain in these areas:

* helping the person to understand causes of fluctuation in pain intensity
* helping the person learn to handle stress and emotions more effectively
* helping the person learn techniques to manage their pain and distress more effectively
* helping the person learn strategies to regain a more restorative sleep pattern
* helping the person and perhaps their family communicate more effectively
* helping the person adapt to a life with chronic pain
* helping the person and their family adjust to their losses and find their own ways to understand their new lives and embrace whatever opportunities are possible for fulfillment
* developing strategies to deal with the limitations that pain has caused

The first relates to understanding causes of fluctuation in pain intensity. Typical causes of changes in pain include things such as stress and other emotions, excessive physical exertion, quality of sleep. A psychologist can help a person learn to handle stress and emotions more effectively and may be able to work with the pain sufferer to organize the physical activities in their lifestyle to limit overexertion.

Psychologists may help the person learn to use various relaxation and mind-body techniques to better manage their pain and reduce their feelings of distress and suffering.

Psychologists may also help a person to learn strategies to help them have a more restorative sleep pattern and to communicate more effectively with their family, friends, colleagues and employers.

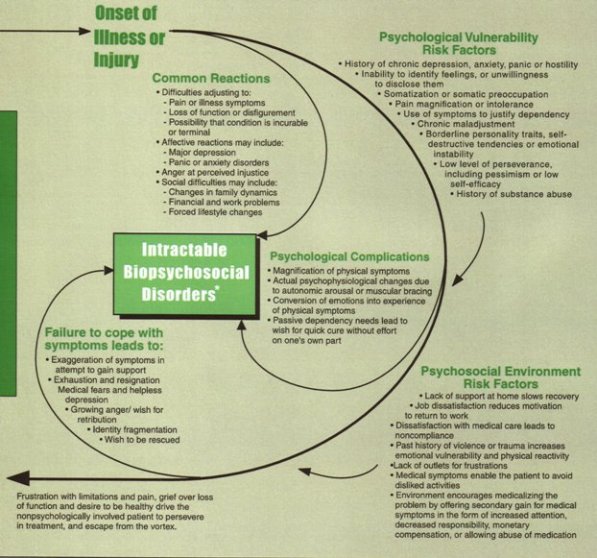
Another area where psychologists may be helpful is in the area of adapting to a life with chronic pain. One important cause of suffering in chronic pain is the sense of having been let down by the health care community and also a sense of uncertainty regarding the future, as well as a profound sense of loss related to the activities and sources of well-being that have been lost through pain. Psychologists are trained in helping people adjust to loss and find their own ways to understand their new lives and embrace whatever opportunities are possible for fulfillment even with ongoing pain and other health problems.

A third way that psychologists can be helpful relates to developing strategies to deal with the limitations that pain has caused. For example, problem solving how to engage in activities outside the home without overdoing it. Learning how to communicate effectively so that others know about your limitations, respect you for your efforts and problem solve with you. Other examples include exploring possibilities for reorienting activities towards "what you still can do" even with pain.

For most people, the most effective strategy to making the most of life with a chronic pain problem is to work with a team of health care professionals in a comprehensive rehabilitation approach. Such an approach usually begins with an expert evaluation of the many facets of the pain problem. This may include assessment by one or more physicians as well as psychologists and other rehabilitation professionals such as physiotherapists and occupational therapists. Rehabilitation treatment is often directed towards the specific problems that face the individual with chronic pain problems. This often involves both physical strategies which may help the underlying condition but also improve flexibility, strength and endurance. Often psychological counselling individually and in groups is offered to address the issues discussed earlier. Where appropriate vocational assessment and counselling may be offered to help a person reintegrate into the workforce.

***Psychological factors play a significant role not only in chronic pain, but also in the etiology of acute pain, particularly in the transition to chronic problems. Specific types of psychological variables emerge and may be important in distinct developmental time frames, also implying that assessment and intervention need to reflect these variables. Still, psychological factors account for only a portion of the variance, thereby highlighting the multidimensional view.***

***The Biopsychosocial Vortex Model of Chronic Pain & Disability***



**Biofeedback, Relaxation Training, and Cognitive Therapy  
May be Effective Adjunctive Treatments for Chronic Pain**

WASHINGTON April, 1998-- Americans spend billions of dollars a year on often-unsuccessful attempts to relieve chronic head or lower back pain. Low back pain is second only to upper respiratory symptoms in causing medical office visits. While most people treat most headaches with over-the-counter medications, there are some for whom neither those drugs nor more potent prescription medications are effective (or tolerable). But according to two articles in the December issue of Professional Psychology: Research and Practice, published by the American Psychological Association (APA), there are effective psychological interventions for both conditions.

In "*Psychological Treatment of Benign Headache Disorders*," Edward B. Blanchard, Ph.D., of the University at Albany, State University of New York and Seymour Diamond, MD, of the Diamond Headache Clinic in Chicago, write that there is now a sizable body of research literature supporting three broad classes of psychological treatments for headache: biofeedback training, varieties of relaxation training and certain specific forms of cognitive therapy. While psychological interventions don't work as quickly as medications— and not all headache sufferers respond to them— they can produce long-lasting (up to five years) relief.

Psychological interventions for headache appear to be especially effective for younger patients, the authors note. Several studies have shown greater improvement has been seen in patients 21 and under than in adults over 45.

The authors say that, unlike medications whose side effects can include drug dependency, the only negative side effect of psychological interventions that has been seen is ineffectiveness, that is, the headache didn't go away. On the other hand, several studies have found that even when psychological interventions are unsuccessful at relieving head pain, they can significantly reduce depression and anxiety in headache sufferers.

The situation with chronic lower back pain is more complicated. In "*Psychophysiologic Treatment of Chronic Lower Back Pain*," authors Richard N. Gevirtz, Ph.D., of the California School of Professional Psychology and David R. Hubbard, MD, and R. Edward Harpin, Ph.D., of the Sharp Pain Rehabilitation Program in San Diego note that "chronic lower back pain is one of the most prevalent yet poorly treated health problems in Western society" and is "neither well understood or treated effectively using medical or surgical techniques."

Meanwhile, the authors say, the research on purely psychological approaches to treating chronic lower back pain has sometimes reached contradictory conclusions, but, they note, "overall, there seems to be a consensus that psychological interventions [such as relaxation training, biofeedback and cognitive and behavioral therapy] are usually efficacious."

Instead of either a purely physical or purely psychological approach to treating chronic lower back pain, the authors propose a psychophysiological model which combines elements of both. They describe an interdisciplinary treatment program in which patients are educated in anatomy and physiology, trained (via biofeedback) in muscle tension awareness, taught to identify the stressors in their daily lives that lead to activation of the muscle tension response and then to take steps to "disarm" those stressors.

The authors conclude that although there is still much to be learned about what causes chronic lower back pain and how best to treat it, viewing it and treating it as both a medical and a psychological disorder may provide better results for people who have it.

**Thinking the Pain Away?**

**PET Study Shows the Brain’s Painkillers May Cause “Placebo Effect”**  
  
Posted August 23, 2005  
Source: University of Michigan Health System

The mechanism of the "placebo effect" has eluded researchers for decades but pieces of the puzzle are falling into place. A new study by SNM member Jon-Kar Zubieta, MD, PhD, at the University of Michigan used 11C-carfentanil PET to demonstrate that just believing that a medicine will relieve pain is enough to prompt the brain to release its own natural painkillers and soothe painful sensations.

The study provides the first direct evidence that the brain’s own pain-fighting chemicals, called endorphins, play a role in the phenomenon known as the placebo effect—and that this response corresponds with a reduction in feelings of pain.

Previous studies at U-M and elsewhere have shown that the brain reacts physically when a person is given a sham pain treatment, which they believe will help them. But the new study is the first to pinpoint a specific brain chemistry mechanism for a pain-related placebo effect. It may help explain why so many people say they get relief from therapies and remedies with no actual physical benefit. And, it may lead to better use of cognitive, or psychological, therapy for people with chronic pain.

The results will be published in the August 24 issue of the *Journal of Neuroscience* by a team from the U-M Molecular and Behavioral Neurosciences Institute (MBNI). The research was funded by the National Institutes of Health.

"This deals another serious blow to the idea that the placebo effect is a purely psychological, not physical, phenomenon," said lead author and SNM member Jon-Kar Zubieta, MD, PhD, associate professor of psychiatry and radiology at the U-M Medical School and associate research scientist at MBNI. "We were able to see that the endorphin system was activated in pain-related areas of the brain, and that activity increased when someone was told they were receiving a medicine to ease their pain. They then reported feeling less pain. The mind-body connection is quite clear."

The findings are based on sophisticated brain scans from 14 young healthy men who agreed to allow researchers to inject their jaw muscles with a concentrated salt water solution to cause pain. The injection was made while they were having their brains scanned by a positron emission tomography (PET) scanner. During one scan, they were told they would receive a medicine (in fact, a placebo) that might relieve pain.

Every 15 seconds during the scans, they were asked to rate the intensity of their pain sensations on a scale of 0 to 100, and they gave more detailed first-person ratings after the experiment. The researchers correlated the participants’ ratings with their PET scan images, which were made using a technique that reveals the activity of the brain’s natural painkilling endorphin chemicals, also called endogenous opioids.

Endogenous opioids bind to brain cell receptors called mu-opioid receptors, and stop the transmission of pain signals from one nerve cell to the next. Besides the brain’s own chemicals, drugs such as heroin, morphine, methadone and anesthetics also act on the mu opioid receptor system to reduce pain.

Because the endorphin system naturally tries to quell pain whenever it occurs, the researchers slowly increased the amount of concentrated salt water being injected in the muscle as the scans continued, in order to keep the participants’ rating of their pain within the same point range throughout the experiment. The placebo, a small amount of hydrating solution, was then given intravenously every four minutes.

As the researchers alerted participants that the placebo was coming, and injected the placebo dose, the amount of additional concentrated salt water needed to maintain participants’ pain over time increased—indicating a reduction in pain sensitivity that the subjects were not aware of. In other words, thinking they were getting a pain drug actually allowed the participants to tolerate even more pain-inducing concentrated salt water than before.

After each scan, the researchers asked the participants more questions about their mood, emotions and other aspects of how they felt during the scans. There were significant differences between post-scan ratings given by participants after the scan in which they received the placebo, and after the scan during which they received the jaw injection alone.

Nine of the participants were classified as "high placebo responders" because they had more than a 20 percent difference between pain and placebo scans in their average pain ratings per volume of salt water infused—in other words, the placebo effect was strong. The other five were classified as "low placebo responders."

These subjective ratings are consistent with previous findings, Zubieta notes. But the simultaneous imaging of the participants’ endogenous pain-reducing opioid systems sheds new light on why the placebo effect occurs.

The imaging method used in the study involves tiny doses of a medicine called carfentanil that is attached to a short lived radioactive form of carbon ( 11C-carfentanil), which releases positrons. These positrons are detected with the PET scanner, which acts like a photographic camera to capture those particles. It then determines exactly which part of the brain they originated from, and how many of them are coming from each brain region. The researchers also made MRI scans of the participants’ brains, which they cross-registered with the PET scans to give accurate information on exactly which brain regions were active.

Because carfentanil competes with the brain’s natural endogenous opioid painkillers for space on nerve cell receptors, the PET scans can be used to see how active the opioid system and mu-opioid receptors are. The stronger the positron signal from a particular brain region, the less active the mu opioid system, and vice versa.

All of the participants showed an increase in the activation of their mu opioid endorphin system after they were told that the "medicine" was coming and the placebo was given. The most pronounced differences were seen in four areas of the brain known to be involved in complex responses to, and processing of, pain: the left dorsolateral prefrontal cortex, the pregenual rostral right anterior cingulate, the right anterior insular cortex and the left nucleus accumbens.

When the researchers correlated the mu opioid activity changes with the participants’ own ratings of their pain and emotions, they also observed that the placebo-induced activation of the opioid system was correlated with various elements of the experience of pain.

For example, activity in the dorsolateral prefrontal cortex was associated with the expectation of pain relief reported by the volunteers. In other areas, that activation was associated with relief of the intensity of pain, how unpleasant it was, or even how the individuals felt emotionally during the pain experience.

Because the new study was done only in healthy men between the ages of 20 and 30, further research will be needed to determine whether the effect occurs in women and in people with various illnesses. The power of placebos to ease pain symptoms has been well-documented in many groups of subjects and illnesses, but the researchers started with healthy young males to rule out the impact of chronic pain, mood disorders and hormone variations, which can also affect the endorphin system.

In addition to Zubieta, the research team included MBNI members Joshua Bueller, Lisa Jackson, David Scott and Janyun Xu; radiology professor and SNM member Robert Koeppe, PhD; Thomas Nichols, PhD, an assistant professor of biostatistics in the U-M School of Public Health; and Christian Stohler, formerly of the U-M School of Dentistry and now at the University of Maryland School of Dentistry.

**My Pain, My Brain**

By MELANIE THERNSTROM

May 14, 2006

Who hasn't wished she could watch her brain at work and make changes to it, the way a painter steps back from a painting, studies it and decides to make the sky a different hue? If only we could spell-check our brain like a text, or reprogram it like a computer to eliminate glitches like pain, [depression](http://topics.nytimes.com/top/news/health/diseasesconditionsandhealthtopics/depression/index.html?inline=nyt-classifier) and learning disabilities. Would we one day become completely transparent to ourselves, and — fully conscious of consciousness — consciously create ourselves as we like?

The glitch I'd like to program out of my brain is [chronic pain](http://topics.nytimes.com/top/news/health/diseasesconditionsandhealthtopics/pain/index.html?inline=nyt-classifier). For the past 10 years, I have been suffering from an arthritic condition that causes chronic pain in my neck that radiates into the right side of my face and right shoulder and arm. Sometimes I picture the pain — soggy, moldy, dark or perhaps ashy, like those alarming pictures of smokers' lungs. Wherever the pain is located, it must look awful by now, after a decade of dominating my brain. I'd like to replace my forehead with a Plexiglas window, set up a camera and film my brain and (since this is my brain, I'm the director) redirect it. *Cut. Those areas that are generating pain — cool it. Those areas that are supposed to be alleviating pain — hello? I need you! Down-regulate pain-perception circuitry, as scientists say. Up-regulate pain-modulation circuitry. Now.*

Recently, I had a glimpse of what that reprogramming would look like. I was lying on my back in a large white plastic fMRI. machine that uses ingenious new software, peering up through 3-D goggles at a small screen. I was experiencing a clinical demonstration of a new technology — real-time functional neuroimaging — used in a Stanford University study, now in its second phase, that allows subjects to see their own brain activity while feeling pain and to try to change that brain activity to control their pain.

Over six sessions, volunteers are being asked to try to increase and decrease their pain while watching the activation of a part of their brain involved in pain perception and modulation. This real-time imaging lets them assess how well they are succeeding. Dr. Sean Mackey, the study's senior investigator and the director of the Neuroimaging and Pain Lab at Stanford, explained that the results of the study's first phase, which were recently published in the prestigious Proceedings of the National Academy of Sciences, showed that while looking at the brain, subjects can learn to control its activation in a way that regulates their pain. While this may be likened to biofeedback, traditional biofeedback provides indirect measures of brain activity through information about heart rate, skin temperature and other autonomic functions, or even EEG waves. Mackey's approach allows subjects to interact with the brain itself.

"It is the mind-body problem — right there on the screen," one of Mackey's collaborators, Christopher deCharms, a neurophysiologist and a principal investigator of the study, told me later. "We are doing something that people have wanted to do for thousands of years. Descartes said, 'I think, therefore I am.' Now we're watching that process as it unfolds."

Suddenly, the machine made a deep rattling sound, and an image flickered before me: *my brain. I am looking at my own brain, as it thinks my own thoughts, including these thoughts.*

How does it work? I want to ask. Just as people were once puzzled by [Freud's](http://topics.nytimes.com/top/reference/timestopics/people/f/sigmund_freud/index.html?inline=nyt-per) talking cure (how does describing problems solve them?), the Stanford study makes us wonder: How can one part of our brain control another by looking at it? Who is the "me" controlling my brain, then? It seems to deepen the mind-body problem, widening the old Cartesian divide by splitting the self into subject and agent.

**But most of all I want to know: *Will I be able to learn it?***

For most of history, the idea of watching the mind at work was as fantastical as documenting a ghost. You could break into the haunted house — slice the brain open — but all you would find would be the house itself, the brain's architecture, not its invisible occupant. Photographing it with X-rays resulted only in pictures of the shell of the house, the skull. The invention of the CT scan and magnetic resonance imaging (MRI) were great advances because they reveal tissue as well as bones — the wallpaper as well as the walls — but the ghost still didn't show up. Consciousness remained elusive.

A newer form of MRI, functional magnetic resonance imaging (fMRI), used with increasingly sophisticated software, is accomplishing this, taking "movies" of brain activity. Researchers are able to watch the brain work, as the films show parts of the brain becoming active under various stimuli by detecting areas of increased blood flow connected with the faster firing of nerve cells. These films are difficult to read; researchers puzzle over the new images like Columbus staring at the gray shoreline, thinking, *India*? Most of the brain is uncharted, the nature of the terrain unclear. But the voyage has been made; the technology exists. Pain — a complex perception occupying the elusive space spanning sensation, emotion and cognition — is a particularly promising area of imaging research because, researchers say, it has the potential to make great progress in a short time.

Perhaps more than any other aspect of human existence, persistent pain is experienced as something we cannot control but desperately wish we could. Acute pain serves the evolutionary function of warning us of tissue damage, but chronic pain does nothing except undo us. Pain is the primary complaint that sends people to the doctor. Of the 50-odd million sufferers in the United States, half cannot get adequate relief from their chronic pain. Many do not even have a diagnosis.

Unlike acute pain, chronic pain is now thought to be a disease of the central nervous system that may or may not correlate with any tissue damage but involves an errant reprogramming in the brain and spinal cord. The brain can generate terrible pain in a wound that is long healed, in a body that is numb and paralyzed or — in the case of phantom-limb pain — in a limb that no longer even exists.

Although there have been many theories about how pain works in the brain, it is only through neuroimaging that the process has actually been observed. It is now clear that there is no single pain center in the brain. Rather, pain is a complex, adaptive network involving 5 to 10 areas of the brain transmitting information back and forth.

This network has two pain systems: pain perception and pain modulation, which involve both overlapping and distinct brain structures. The pain-modulatory system constantly interacts with the pain-perception system, inhibiting its activity. Much chronic pain is thought to involve either an overactive pain-perception circuit or an underactive pain-modulation circuit.

Like everyone who suffers from chronic pain, I find it hard to believe that I have a pain-modulation circuit. The aspect of my pain I feel most certain about is that it is not voluntary: I cannot modulate it. And this belief is reinforced every single day that I suffer from pain, which is every day. Yet I know that pain is not a fact, like a broken bone; it's a perception, like hunger, about a physical state ("an unpleasant sensory and emotional experience associated with actual or potential tissue damage or described in terms of such damage," as the International Association for the Study of Pain defines it). And it's a mercurial perception; under certain circumstances the pain-modulatory system works like a spell and the brain completely blocks out pain.

Soldiers, athletes, martyrs and pilgrims engage in battles, athletic feats or acts of devotion without being distracted by the pain of injuries. When the teenage surfer Bethany Hamilton's arm was bitten off by a shark, she felt pressure, but "I didn't feel any pain — I'm really lucky, because if I felt pain, things might not have gone as well," she said (articulating one reason the modulatory system evolved: if she had thrashed about in pain, she would have bled until she drowned).

In addition to being activated by stress, the pain-modulatory system is triggered by belief. The brain will shut down pain if it believes it has been given pain relief, even when it hasn't (the placebo effect), and it will augment pain if it believes you are being hurt, even if you aren't (the nocebo effect). The brain's modulatory system relies on endogenous endorphins, its own opiatelike substances. The nature of a placebo has long been a source of speculation and debate, but neuroimaging studies have shown the way a placebo actually helps to activate the pain-modulatory system.

In a recently published study led by Dr. Jon-Kar Zubieta at the [University of Michigan](http://topics.nytimes.com/top/reference/timestopics/organizations/u/university_of_michigan/index.html?inline=nyt-org) Medical School, the brains of 14 men were imaged after a stinging saltwater solution was injected into their jaws. They were then each given a placebo and told that it would positively relieve their pain. The men immediately felt better — and the screen showed how. Parts of the brain that release endogenous opiates lighted up. In other words, fake opiates caused the brain to dispense real ones. Like some New Age dictum, philosophy becomes chemistry; believing becomes reality; the mind unites with the body.

Other studies have shown that opiates and other medications *rely on a placebo* to achieve part of their effect. When subjects are covertly given strong opiates like morphine, they don't work nearly as well as they do if the subjects are told they are being given a powerful pain reliever. Even real medications require some of the brain's own bounty.

Conversely, thinking about pain creates pain. In studies at Oxford University, Irene Tracey has shown that asking subjects to think about their chronic pain, for example, increases activation in their pain-perception circuits. Distraction, on the other hand, is a great analgesic; when Tracey's volunteers were asked to engage in a complicated counting task while being subjected to a painful heat stimulus, she could watch the pain-perception matrix decrease while cognitive parts of the brain involved in counting lighted up. At McGill University, Catherine Bushnell has shown that simply listening to tones while being subjected to a heat stimulus decreased activity in the pain-perception circuit. +++

"There is an interesting irony to pain," comments Christopher deCharms, who worked with Mackey designing and carrying out the Stanford study. We were talking in his office at Omneuron, a Menlo Park medical-technology company he founded three years ago to develop clinical applications of neuroimaging. "Everyone is born with a system designed to turn off pain. There isn't an obvious mechanism to turn off other diseases like [Parkinson's](http://topics.nytimes.com/top/news/health/diseasesconditionsandhealthtopics/parkinsonsdisease/index.html?inline=nyt-classifier). With pain, the system is there, but we don't have control over the dial."

The goal of the Stanford technique is to teach people to control their dials — to activate their modulatory systems without requiring the extreme stress of fleeing from a shark or the deception of a placebo. The hope of neuroimaging therapy (as deCharms calls the Stanford technique) is that repeated practice will strengthen and eventually change the ineffective modulatory system to eliminate chronic pain, the way long-term [physical therapy](http://topics.nytimes.com/top/news/health/diseasesconditionsandhealthtopics/physicaltherapy/index.html?inline=nyt-classifier) can change muscular weakness. The scan would thus be more than a research tool: *the scan itself would be the treatment,* and the subject his or her own researcher.

Only once do I recall having a glimmer of my own pain-modulatory system at work: a hidden power that emerged, dispensed with pain and then returned to some forgotten fold in my brain, where I have never been able to locate it again. The event did not take place on a battlefield or a marathon course or in a temple; it was in a basement of the Stanford University medical center three years ago. At the time, Mackey had designed an earlier study that did not use imaging technology but focused on how suggestion alters pain perception. Although I was not formally enrolled in the study, I asked if I could undergo a clinical demonstration. My experience illustrated the power of suggestion in an unexpected fashion.

A metal probe attached to the underbelly of my arm heated up and cooled down at set intervals. I was told that although the heat probe would feel uncomfortable, my skin would not be burned. During one exposure, I was instructed to think of the pain as positively as possible, during another to think of it as negatively. After each sequence, I was asked to rate my pain on a 0-to-10 scale, with 10 being the worst pain I could imagine.

Although I discovered that I could make the pain fluctuate depending on whether I was imagining that I was sunbathing or was the victim of an inquisition, I still rated all the pain as low — ranging from a 1 to a 3. If 10 was being slowly burned alive, I felt I should at least be begging for mercy to justify a rating of 5. So I insisted that Mackey turn up the dial so I could get a real response. But even during the moments when I was actively trying to imagine the pain as negatively as possible, it remained in a mental box of "not even burned," which kept it from really hurting: hurting, that is, the way a burn would.

As it turned out, I got a second-degree burn that later darkened into a square mark. Mackey was more than a little dismayed as we watched the reddening skin pucker, but I was thrilled. Naturally the protocol had been carefully designed not to injure anyone, yet in my case that protection had failed *because of the very phenomenon it was designed to study*: expectation — the effect of the mind on pain or placebo.

I had recently spent several weeks observing Mackey in the university's pain clinic, where he is associate director. I was so convinced that Mackey — then a tall sandy-haired 39-year-old with a deep interest in technology (he got a Ph.D. in electrical engineering before he went to medical school) and an air of radiant integrity — would not burn me that my brain had not perceived the stimulus as a threat and generated pain. I admired him, I trusted him, I was positive that he wouldn't hurt me. And, ipso facto, he hadn't.

Mackey's genius as a practitioner, I thought, lay partly in his ability to similarly inspire patients. "When I started working with pain patients, I realized how much of the treatment involved trying to reverse learned helplessness," he said — to rally them out of the despair ingrained from years of unremitting pain and cajole their minds to chip in its own analgesic to their therapies. "The purpose of this study is to show patients their mind matters," Mackey said.

The mark of the burn is barely visible now, but for a couple of years afterward, at times when my chronic pain was making me miserable, the sight of it would both encourage and reproach me. *Here is the ultimate proof that my mind can control pain,* I would think, yet I didn't know how to make it wake up and do so. I could take the edge off the pain by conjuring positive images, but the effects didn't last, and I never again had the remarkable placebo response that masked a second-degree burn. In fact, a mild burn from spilling tea on my hand one day brought tears to my eyes.

**When the real-time neuroimaging study began, I couldn't wait to try it.**

The area of the brain that the scanner focuses on is the rostral anterior cingulate cortex (rACC). The rACC (a quarter-size patch in the middle-front of the brain, the cingular cortex) plays a critical role in the awareness of the nastiness of pain: the feeling of dislike for it, a loathing so intense that you are immediately compelled to try to make it stop. Indeed, the pain of pain, you might say, its defining element, is the way in which the sensation is suffused with a particular unpleasantness researchers refer to as dysphoria. Since pain is a perception, it's not pain if you don't experience it as hurting. You can feel hot or cold or pressure, and note them simply as stimuli, but when they exceed a certain intensity, the rACC kicks in, and suddenly they become painful, riveting your attention and causing you to recoil.

Many pain-reducing techniques aim to manipulate the conscious awareness of pain. Distraction, placebo, meditation, imagining pleasant scenes and hypnosis all result in a reduction of rACC activation when they work. Patients who have undergone a radical surgical treatment occasionally used for pain (as well as for [mental illness](http://topics.nytimes.com/top/news/health/diseasesconditionsandhealthtopics/mentalhealthanddisorders/index.html?inline=nyt-classifier)) called a cingulotomy, in which the rACC is partly destroyed, report that they are still aware of pain but that they don't "mind" it anymore. Their emotional response has receded.

The image I saw while lying in the f.M.R.I. machine at the time of the recent Stanford study was not literally my rACC but a visual analogue of it that is easier to see: a 3-D image of a fire. The flames represent the degree of activation in your rACC: when it is low, the flames are low; when rACC activation is high, the flames flare. The study involves five 13-minute scanning runs, each consisting of five cycles of a 30-second rest followed by a 1-minute interval in which you try to increase rACC activation and then a 1-minute interval in which you try to decrease rACC activation.

Before my scan began, I was prepped in different mental strategies for increasing and modulating my pain. Everyone's brain works a bit differently, though, so subjects have to experiment in the scanner to see what is most effective for them. For some, trying to distract themselves from their pain works best; for others, focusing on their pain — like embracing a Zen koan — seems to be what triggers their pain-modulatory system. When deCharms used neuroimaging therapy on himself to try to alleviate his chronic neck pain, he concentrated on the pain itself and felt it "suddenly melt away." He said that a patient described the feeling as being "like a runner's high" (a state that has been shown to involve the release of endogenous endorphins).

*Increase Your Pain,* the screen commanded, as the first run began. I tried to recall the mental strategies in which I had been prepped for increasing pain: *Dwell on how hopeless, depressed or lonely you felt when your pain was most severe. Sense that the pain is causing long-term damage.*

Dwelling on the hopeless loneliness of my pain certainly made the flames of my rACC spark. The mental image that I found increased my pain the most, however, was the one that matched the visual analogue of the rACC: *Picture a hot flame on your painful area. Try to make the flame grow in the painful area, and imagine it actually burning your flesh.*

Having recently read Ariel Glucklich's extraordinary "Sacred Pain," I had plenty of details of the burning of heretics and witches available to me. I had only to imagine the smell of sizzling hair to make the flames of my rACC explode.

*Decrease Pain,* the screen commanded.

The suggested pain-reduction strategies, however, did little to quell the flames on the screen. I pictured suffocating the pain with banal positive imagery: *flowing water or honey, something soft and gentle,* but my mind kept slipping back to the progress of the auto-da-fé, and the rACC fire flared.

*Feel that sensation, but tell yourself that it is just a completely harmless, short-term tactile sensation.*

Pilgrims and devotees all around the world choose to inflict pain upon themselves during sacred rites — from being nailed to crosses to dangling from hooks. For them, pain is an occasion for euphoria, not dysphoria. There are many historical records of the equanimity saints and martyrs often possessed during torture. The second-century Jewish martyr Rabbi Akiva, for example, continued to recite a prayer with a smile on his lips *while the flesh was being combed from his bones*. "All my life," he explained to the puzzled Roman general orchestrating his execution, "when I said the words 'You shall love the Lord your God with all your heart, with all your soul, and with all your might,' I was saddened, for I thought, When shall I be able to fulfill this command? Now that I am giving my life and my resolution remains firm, should I not smile?"

As Glucklich writes, the conviction that pain is a spiritual opportunity seems paradoxically anesthetizing — or, as a scientist would say, religious states of conviction can robustly activate the pain-modulatory system.

During my next Decrease Pain interval, instead of trying to picture a vacation, I imagined myself as a martyr, lucidly reciting *Though I walk through the valley of the shadow of death* while being burned at the stake. My rACC activation — I noted — respectfully quieted. Then I remembered that the 23rd Psalm seems to have Christian associations, and since I was presumably being tortured for being half-Jewish, a Jewish prayer might be more appropriate. Unless, that is, I was being accused of witchcraft, in which case, I might be generally disillusioned with Judeo-Christian prayer. As I tried to settle on a fantasy, I noticed that my rACC stayed low: Irene Tracey's theory of the modulating effects of distraction. By the last run, I had the strategies down — heretic-martyr: rACC down; heretic-victim: rACC up.

The results of the scan, Mackey showed me, revealed significant brain control. A week later, I was scanned again, this time in the offices of Omneuron. I could feel that it was easier to control my rACC with less reliance on elaborate fantasy; I was interacting more directly with my brain.

This learning effect was clearly seen in the recent Stanford study (which was financed in part by the National Institutes of Health). The first phase of the study looked at 12 subjects with chronic pain and 36 healthy subjects. (The healthy participants were subjected to a painful heat stimulus in the scanner and tried to modulate their responses. The chronic-pain patients, however, simply worked to reduce their own pain.) The chronic-pain patients who underwent neuroimaging training reported an average decrease of 64 percent in pain rating by the end of the study. (Healthy subjects also reported a significant increase in their ability to control the pain.)

"One big concern we had," Mackey says, "is, Were we creating the world's most expensive placebo?" To ensure against that, Mackey trained a control group in pain-reduction techniques without using the scanner (as in his previous study) to see if that was as effective as employing a $2 million machine. Mackey also tried scanning subjects without showing them their brain images or tricking subjects by feeding them images of irrelevant parts of the brain or feeding them someone else's brain images. "None of these worked," Mackey says, "or worked nearly as well." Traditional biofeedback also compared unfavorably; changes in pain ratings of subjects in the experimental group were three times as large as in the biofeedback control group.

The second phase of the study, which is now under way, is designed to assess whether neuroimaging therapy offers long-term practical benefits to a larger group of chronic-pain patients. After the six sessions designed to teach them to regulate their pain, they will be observed for at least six months. The idea is to see whether they can fundamentally change their modulation system so that it can reduce pain all the time without constantly and consciously thinking about it. If so, the technique would not simply provide shelter from the storm of pain; it would bring about climate change.

"I believe the technique may make lasting changes because the brain is a machine designed to learn," deCharms says. The brain is soft-wired (plastic) rather than hard-wired: whenever you learn something new, new neural connections are believed to form and old, unused ones to wither away. (Researchers refer to this as activity-dependent neuroplasticity.) In other words, if you actively engage a certain brain region, you can alter it.

Many diseases of the central nervous system involve inappropriate levels of activation in particular brain regions that change the way they operate (negative neuroplasticity). Some regions experience atrophy, while other regions become hyperactive. (For example, [epilepsy](http://topics.nytimes.com/top/news/health/diseasesconditionsandhealthtopics/epilepsy/index.html?inline=nyt-classifier) involves hyperactivity of cells; stroke, Parkinson's and other diseases involve the atrophy of nerve cells.) With chronic pain, it is believed that additional nerve cells, recruited for transmitting pain, create more pain pathways in the nervous system, while nerve cells that normally inhibit or slow the signaling, decrease or change function.

In addition, chronic pain results in a significant loss of other kinds of brain cells. A. Vania Apkarian at Northwestern University found that while the brain of a healthy person shrinks 2.5 percent a year, in a person with chronic back pain, it shrinks an additional 1.3 percent annually in the areas that involve rational thinking. I know chronic pain interferes with my concentration at times, but I never imagined that it could be truly impairing it! The Stanford technique may mitigate this harm by teaching people how to increase the efficacy of the healthy cells.

Moreover, the technique may offer a particular advantage over drug therapy. It is very difficult to design drugs to fix a problem in a specific region of the brain because the receptors that drugs target, like the opiate receptors, generally appear in multiple systems throughout the brain (which is partly why drugs almost always have side-effects). Neuroimaging therapy, on the other hand, is designed to teach control of a localized brain region.

"The technique gives people a tool they didn't know they had," Mackey says, "cognitive control over neuroplasticity. We don't fully understand how this feedback mechanism is working, but it provides tangible evidence that people can change something in their own brains, which can be very empowering. It takes Buddhist monks 30 years of sitting on a mountain learning to control their brains through meditation — we're trying to jump-start that process." As to how exactly it works — how the decision-making parts of the brain (the prefrontal regions of the cortex) cause the change in the rACC — "Heck if I know!" he says. "How do we get the brain to do anything? We can map out the anatomical circuits involved and the general functions of those circuits, but we can't tell you the mechanism by which any cognitive decision is translated into action."

If neuroimaging therapy could treat pain, could it rewire the brain to fix other diseases, like depression, stroke and learning disabilities, or exercise the brain in ways that would make it cleverer and more adept at certain skills? Neuroimaging has shown, for example, that the part of the brains of London cabdrivers that regulates spatial relations is larger than usual and that learning to juggle creates visible changes in parts of the brain involved with motor coordination during three months of training. I'm constantly getting lost and dropping things. Could I exercise and strengthen those areas more quickly by, say, thinking about maps in the scanner than by driving around London?

"What is the limit to neuroimaging therapy?" deCharms muses. "Could you learn to target the reward or serotonin system and up-regulate happiness? Could you augment psychotherapy by allowing the patient and the therapist to watch the brain?" — an idea Omneuron is already exploring, by bringing therapists and patients to the scanner and imaging patients' brains as they undergo the sessions. "After all, talk therapy is about learning to understand thought processes — to understand neural substrates and change them," he says.

How deep can the insights that functional imaging might offer really go?

What I'd like to do most is not fix problems or improve skills but use imaging as a vehicle for self-transparency. Instead of puzzling about my motivations, I'd like to be able to read my mind completely, like a book: for imaging to be the Plexiglas window through which I could finally see the ghost.

"Hmm," Dr. Scott Fishman, chief of the pain-medicine division at the [University of California](http://topics.nytimes.com/top/reference/timestopics/organizations/u/university_of_california/index.html?inline=nyt-org), Davis, said dubiously when I brought up this notion. "I'm not sure that functional imaging is actually looking at the mind. The mind is like a virtual organ — it doesn't have a physical address that we know about. Functional imaging provides a two-dimensional snapshot of a three-dimensional or a four-dimensional event of this entity of the mind. Right now, imaging is just looking at the brain; we have to be honest about that." Imaging shows the level of activation of different parts of the brain, from which we can extrapolate something about the mind, he points out, "but what we really need to see is how the parts talk to each other — and the complex nuances of their language."

The brain has more than a hundred billion neurons. All functional imaging can tell us now is that a few hundred million of them in various areas become more active at certain times. It's as if you were trying to conduct a symphony by watching a silent film of the concert. You would see the players in the bass section active at one moment, vigorously gesturing, and then the rest of the orchestra would join in, but you couldn't hear the notes or how they form strands of melody and harmony and meld together to create the ethereal experience.

"Consciousness is not neurons firing — consciousness is a transcendent emergent phenomenon that depends on the firing of neurons," says Dr. Daniel Carr, an eminent pain researcher who is now the C.E.O. of Javelin [Pharmaceuticals](http://topics.nytimes.com/top/news/health/diseasesconditionsandhealthtopics/drugspharmaceuticals/index.html?inline=nyt-classifier). "The gears of a watch rotate and keep time, but the turning of the gears is not time. The question is, Is neuroimaging a picture of the experience of consciousness or is it a picture of a mechanism associated with that experience? Can there actually be a picture of an experience? Does a picture of a funeral or a wedding show you experiences? Or is there an unbridgeable gap there because you need to already understand the experience in order to interpret the photos? If a higher being told us how consciousness works, could we understand the explanation?"

*Melanie Thernstrom is a contributing writer for the magazine. She is working on a book about pain.*

**Pain *is* in the brain. To view an excellent video explaining how pain is processed by the brain, GOTO:** [**http://www.youtube.com/watch?v=n8y04SrkEZU&feature=related**](http://www.youtube.com/watch?v=n8y04SrkEZU&feature=related)

**Reduction of Pain Catastrophizing Mediates the Outcome  
of Both Physical and Cognitive-Behavioral Treatment  
in Chronic Low Back Pain**

**Rob J.E.M. Smeets, Johan W.S. Vlaeyen[†](http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6WKH-4JR5FWV-B&_coverDate=04%2F30%2F2006&_alid=390919954&_rdoc=1&_fmt=&_orig=search&_qd=1&_cdi=6907&_sort=d&view=c&_acct=C000050221&_version=1&_urlVersion=0&_userid=10&md5=f4ad57cd73ffbef463d3f031ecff55ae" \l "aff2#aff2), Arnold D.M. Kester[‡](http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6WKH-4JR5FWV-B&_coverDate=04%2F30%2F2006&_alid=390919954&_rdoc=1&_fmt=&_orig=search&_qd=1&_cdi=6907&_sort=d&view=c&_acct=C000050221&_version=1&_urlVersion=0&_userid=10&md5=f4ad57cd73ffbef463d3f031ecff55ae" \l "aff3#aff3)  
and J. André Knottnerus[§](http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6WKH-4JR5FWV-B&_coverDate=04%2F30%2F2006&_alid=390919954&_rdoc=1&_fmt=&_orig=search&_qd=1&_cdi=6907&_sort=d&view=c&_acct=C000050221&_version=1&_urlVersion=0&_userid=10&md5=f4ad57cd73ffbef463d3f031ecff55ae" \l "aff4#aff4)**

?Rehabilitation Centre Blixembosch, Eindhoven, The Netherlands  
†Department of Medical, Clinical and Experimental Psychology, University of Maastricht, Maastricht, The Netherlands  
‡Department of Methodology and Statistics, University of Maastricht, Maastricht, The Netherlands  
§Netherlands School of Primary Care Research, University of Maastricht, Maastricht, The Netherlands

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**Abstract**

The aim of this study was to examine whether treatments based on different theories change pain catastrophizing and internal control of pain, and whether changes in these factors mediate treatment outcome. Participants were 211 patients with nonspecific chronic low back pain (CLBP) participating in a randomized controlled trial, attending active physical treatment (APT, n = 52), cognitive-behavioral treatment (CBT, n = 55), treatment combining the APT and CBT (CT, n = 55), or waiting list (WL, n = 49). Pain catastrophizing decreased in all 3 active treatment groups and not in the WL. There was no difference in the change in internal control across all 4 groups. In all the active treatment groups, patients improved regarding perceived disability, main complaints, and current pain at post-treatment, and no changes were observed in the WL group. Depression only changed significantly in the APT group. Change in pain catastrophizing mediated the reduction of disability, main complaints, and pain intensity. In the APT condition, pain catastrophizing also mediated the reduction of depression. Not only cognitive-behavioral treatments but also a physical treatment produced changes in pain catastrophizing that seemed to mediate the outcome of the treatment significantly. The implications and limitations of these results are discussed.

**Perspective**

This article shows that treatment elements that do not deliberately target cognitive factors can reduce pain catastrophizing. Reduction in pain catastrophizing seemed to mediate the improvement of functioning in patients with chronic low back pain. The results might contribute to the development of more effective interventions.

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**Psychological therapies don’t just help you cope with physical pain, they actually reduce it.**

Researchers have dramatically shown that Cognitive Behavioral Therapy (CBT) can be as effective in treating chronic low back pain as lumbar spinal fusion surgery. Changing the way a person thinks about and interprets pain can greatly alter the experience of pain.

A recent meta-analysis of research in the management of chronic low back pain coauthored by Dr. Benson Hoffman, a Clinical Associate at Duke University Medical Center, concluded that CBT, behavioral therapies, and self-regulatory therapies (e.g., biofeedback, hypnosis, and relaxation training) were all highly effective in treating people with chronic low back pain. Dr. Hoffman reported that he expected these therapies would help people cope with pain, return to work, and possibly reduce depression but was surprised to find their greatest impact was on pain intensity. He found that these treatments don’t just help people deal with their physical discomfort, they actually reduce it.

Pain is not only a sensory event but also a complex emotional experience shaped by our thoughts and beliefs about the causes and consequences of the pain, as well as by our reactions to stress and our social world.

Emotional arousal can influence pain directly by increasing muscle tension and altering levels of hormones in the body and neurotransmitters in the brain associated with pain. It may also have an indirect impact. Fear of re-injury or more pain, for example, can lead us to limit or avoid activities, which then decreases muscle strength and causes further loss of function and more pain and disability. Those in pain often feel angry, frightened, helpless, resentful, depressed, or guilty about being a burden, and they may try and bottle it up to ease others’ discomfort. But suffering is a social experience. Partners and loved ones also experience intense feelings—they have to watch someone they care about in distresss—and they too tend to hold in their feelings of sadness, anxiety, or inadequacy. Such complex feelings and social interactions clearly impact the pain experience and behaviour of the person in pain.

Finally, brain imaging studies are increasingly showing us how the brain changes itself in response to our experience and thoughts. When we repeatedly think negative and catastrophizing thoughts in response to pain, we increasingly activate brain systems associated with feelings of anxiety, fear and the stress response and make these systems more sensitive to being triggered. Over time, the brain remodels itself in ways that increase the feelings of suffering associated with the pain.

Cognitive-behavioral therapies, relaxation, stress-management, and self-regulation training are ways to diminish, prevent or even reverse these functional brain changes.

**Five Ways to Tame the Pain**

Consider these complements to a conventional medical approach…

* **Diversion techniques**, such as visualization and guided imagery training, shift your attention away from the pain. Even music and aromatherapy have been shown to reduce pain sensitivity through distraction.
* **Biofeedback, relaxation**, controlled breathing, meditation, and self-hypnosis teach you to respond to pain and stresss with mental relaxion. They help you learn to ease your muscles rather than tense them, which increases pain.
* **Cognitive restructuring** helps curb negative thinking and catastrophizing—“This will never get better, nothing works!”—in favour of more helpful and realistic thoughts—“yes, I had a pain flare, I’ve had them before and they don’t last forever.”
* **Activity pacing** helps you gradually increase your tolerance for activities by understanding your limits, alternating moderate periods of activity with rest, and stopping before the pain becomes severe. This halts a devastating cycle: Fear of pain leads to avoiding activities and a gradual loss of function, which then leads to more pain and disability.
* **Operant conditioning** is based on the observation that pain behaviours—grimacing, moaning, limping, withdrawing from activities—can become habitual because of the responses they elicit from your spouse or friends or doctors. Along with teaching you coping skills, operant conditioning trains your partner or family members to reinforce efforts you make toward coping and self-management, rather than reward negative behaviours.